SEMESTER - IV

CORE PAPER - X

NUCLEAR AND PARTICLE PHYSICS

Instructional Hrs. :90 **Sub. Code : 16PHPC410**

Max. Marks : CIA -25; ESE -75 **Credits: 4**

Objective : To introduce the students to the basic concepts of Thermodynamics .To make them prepare for state & national level physics examinations.

Unit -I **18 Hrs.**

Nuclear force and Binding

Properties of Nuclear Force - Ground state properties of Deuteron - Square well solution of Deuteron - Low energy, neutron proton scattering - Limits of energy for the scattering of different partial waves - Binding energy - Weizacker's semi empirical mass formula - Application of semi empirical formula for alpha decay - mass parabola for stability of nuclei against beta decay - Evidence of shell effects - Single particle energy levels for infinite square well, harmonic oscillator with spin orbit potential - Application of shell model for spin and parity

Unit -II **18 Hrs.**

Radioactive disintegration

Properties of radioactive rays - Law of radioactivity - Half life and mean life- Radioactive equilibrium - Radioactive series - Range of alpha particles - Alpha spectrum and Fine structure - Alpha-Particle Disintegration Energy- Gamow's theory of Alpha decay - Energetics of Beta decay - Beta-Ray Spectra- Pauli's neutrino hypothesis - Properties of neutrino - Gamma emission - Selection rules - internal conversion - Fission process on the basis of liquid drop model - Nuclear fission energetics - Stability limits against spontaneous fission - Potential for fission - Bohr-Wheeler model

Unit -III **18 Hrs.**

Nuclear reactions

Types of nuclear reaction - Conservation laws in nuclear reactions - Balance of Mass and Energy in nuclear reactions - The Q equation and its solution - Proton, deuteron, neutron and alpha induced reactions - Cross section of nuclear reactions - Separation

of center of mass motion in two body problem - Partial wave method for scattering and reaction cross section - Compound nucleus hypothesis -Breit Wigner one level formula

Unit -IV **18 Hrs.**

Neutron Physics and detectors

Properties of neutron - Classification of neutrons according to energy - Sources of neutron - Neutron detectors - Neutron multiplication and fission chain reaction - Four factor formula -Reactor materials - Geiger Muller counter -Semi conductor detectors (Diffused junction detector, Surface barrier detector) - Uses of semiconductor detectors - Scintillation detector

Unit- V **18 Hrs.**

Particle Physics

Meson Physics - Yukawa's hypothesis - Properties of Pi mesons - Classification of elementary particles -- Particle Interaction types - Feynman diagram for electromagnetic interaction, np interaction, weak decays - Symmetry and Conservation laws - Energy and momentum - Angular momentum - Parity - Baryon number - Lepton number - Isospin - Strangeness and Charm - Quark model - Isospin versus strangeness chart (Super multiplet) of mesons and baryons, three quark triplet, quark anti quark couplings

Note: *Italics* denotes Self Study Topics

TEXT BOOKS

1. **S.N. Ghosal**,*Nuclear Physics*, S. Chand Company Ltd (2010)
2. **D.C. Tayal**,*Nuclear Physics*, Himalaya Publishing House Ltd.,
3. **Pandya and Yadav,** *Elements of Nuclear Physics*, Nath & Co, Meerut, 1983,

REFERENCE BOOKS

1. **S.B. Patel,** *Nuclear Physics an Introduction*, New Age international Publishers, 2009
2. **K.S. Krane,** *Introductory Nuclear Physics*, Wiley India Ltd.,
3. **I. Kaplan**,*NuclearPhysics*s, Narosa Publishing House 2002

SEMESTER - IV

CORE PAPER - XI

MOLECULAR SPECTROSCOPY

Instructional Hrs. :90 **Sub. Code : 16PHPC411**

Max. Marks : CIA -25; ESE -75 **Credits: 4**

Objective : To introduce the students to the basic concepts of Spectroscopy .To make them prepare for state & national level physics examinations.

Unit-I **18 Hrs.**

Microwave and Raman Spectroscopy

Rotation of molecules and their spectra - diatomic molecules - intensity of line spectra - the effect of isotropic substitution - non-rigid rotator and their spectra - polyatomic molecules (linear and symmetric top molecules) - Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules).

Unit-II **18 Hrs.**

Infra-red and Raman Spectroscopy

The energy of diatomic molecules - Simple Harmonic Oscillator -the Anharmonic oscillator - the diatomic vibrating rotator - vibration-rotation spectrum of carbon monoxide - breakdown of Born-Oppenheimer approximation - the vibrations of polyatomic molecules - influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) - Raman activity of vibrations - vibrational Raman spectra - vibrations of Spherical top molecules.

Unit-III **18 Hrs.**

Electronic Spectroscopy of Atoms

Electronic wave function and atomic quantum numbers - hydrogen spectrum -orbital, spin and total angular momentum - fine structure of hydrogen atom - many electron spectrum: Lithium atom spectrum, angular momentum of many electrons - term symbols - the spectrum of helium and alkaline earths - equivalent and non equivalent electrons -basics of X-ray photoelectron spectroscopy.

Unit-IV **18 Hrs.**

Electronic Spectroscopy of Molecules

Diatomic molecular spectra: Born-Oppenheimer approximation - vibrational spectra and their progressions - Franck-Condon principle - dissociation energy and their products - rotational fine structure of electronic-vibration transition - molecular orbital theory - the spectrum of molecular hydrogen - change of shape on excitation - chemical analysis by electronic spectroscopy - reemission of energy -fundamentals of UV photoelectron spectroscopy.

Unit-V **18 Hrs.**

Spin Resonance Spectroscopy

Spin and magnetic field interaction - Larmor precession - relaxation time - spin-spin relaxation - spin-lattice relaxation - NMR chemical shift - coupling constants -

coupling between nuclei -chemical analysis by NMR - NMR for nuclei other than hydrogen - ESR spectroscopy - fine structure in ESR.

Note :*Italics* denotes Self Study Topics

TEXT BOOKS

1.**Aruldhas.G**, *Molecular structure and spectroscopy*, PHI Learning Pvt Ltd, New Delhi,2008.

REFERENCE BOOKS

1. **Gupta., Kumar., Sharma**., *Spectroscopy*, Pragati Prakashan, Meerut, 2006.
2. **Gurdeep R.Chatwal,***Spectroscopy(Atomic and Molcular),*Himalaya Publishing House, New Delhi,2006.
3. **Straughan and S.Walker**.,*Spectroscopy,* Vol 1, 2, 3, Chapman & Hall, Chennai, 1976.
4. **Banwell**. **C.N.**,*Spectroscopy,*, III edition, Tata McGraw Hill, New Delhi, 1980.
5. **Barrow**. **G.M.**, *Introduction to molecular spectroscopy* , Tata McGraw Hill, New Delhi, 1962.

SEMESTER-IV

CORE PRACTICAL - IV

SPECIAL ELECTRONICS

Inst.Hrs:120
Sub.Code:16PHPCP04

Max.Marks: CIA-40; ESE-60 **Credits: 4**

Any Twelve Experiments

1. OP-Amp : Circuits using diodes - Half wave, full wave, clipper and clamper
2. IC 555 timer application - Monostable and AstableMultivibrator
3. A/D Converters - any one method.
4. D/A Converters - Binary weighted and Ladder methods
5. Modulation Counter
6. 7473 -Up/Down Counter ,Shift Register, Ring Counter and Johnson Counter
7. Instrumentation amplifier
8. Tunnel diode - characteristics
9. Square and Square root of a single byte , two digit BCD number.
10. Code Conversions - (i) Decimal to Hexadecimal (ii) Hexadecimal to Decimal (iii) Hexadecimal to ASCII and (iv) ASCII to Hexadecimal.
11. Largest /Smallest number in an array and Ascending / descending order of N numbers.
12. LED Interfacing.
13. Stepper Motor Interfacing.
14. Traffic control simulation.
15. Hex Key board interfacing.
16. Musical Tone Generator.
17. ADC Interface.
18. DAC Interface.

SEMESTER – I

CODE	COURSE TITLE
18PHPC102	MATHEMATICAL PHYSICS – I

Category	CIA	ESE	L	T	P	Credit
Core	25	75	71	4	-	4

Preamble

The aim of this subject is to introduce the basic mathematical topics necessary to realize and appreciate various physical laws of nature. It also provides the ability to formulate, interpret and draw inferences from mathematical solutions and to develop problem solving skills that contributes to innovation and applications of basic research.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Analyze the properties of different types of matrices and utilizing the idea of matrices and determinants to solve sets of simultaneous linear equations arising out of physical problems	K4
CO2	Apply to solve ordinary second order differential equations essential in physical problems	K3
CO3	Acquires Knowledge about different special mathematical functions	K3
CO4	Relate Laplace transform methods to solve elementary differential equations of interest in physics and engineering	K2
CO5	Expand periodic functions using Fourier series under a valid condition	K2

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	L	S
CO2	M	S	S	S	S
CO3	S	M	S	M	S
CO4	M	S	M	S	M
CO5	S	M	S	S	S

S- Strong; M-Medium; L-Low

Syllabus

Unit-I **(15 Hrs.)**

Matrices and Determinants :

Properties of matrix addition and multiplication - different type of matrices and their properties - Rank of a Matrix and some of its theorems - Solution to linear homogeneous and non homogeneous equations - Cramers rule – eigen values and eigenvectors of matrices - differentiation and integration of matrix.

Unit-II **(15 Hrs.)**

Solving of differential equations : Homogeneous linear equations of second order with constant coefficients and their solutions - ordinary second order differential with variable coefficients and their solution by power series and Frobenius methods - extended power series method for indicial equations.

Unit-III

(15 Hrs.)

Special differential equations and their solutions :

Legendre's differential equation: Legendre polynomials - Generating functions - Recurrence Formulae–Rodrigue's formula - orthogonality of Legendre's polynomial;Bessel's differential equation: Bessel's polynomial - generating functions - Recurrence Formulae - orthogonal properties of Bessel's polynomials - Hermite differential equation - Hermite polynomials - generating functions - recurrence relation.

Unit-IV **(15 Hrs.)**

Laplace Transform :

Laplace transforms: Linearity property, first and second translation property of LT - Derivatives of Laplace transforms - Laplace transform of integrals - Initial and Final value theorems; Methods for finding LT:direct and series expansion method, Method of differential equation; Inverse Laplace transforms: Linearity property, first and second translation property, Convolution property - Application of LT to differential equations and boundary value problems.

Unit-V (15 Hrs.)

Fourier series and integrals :

Fourier series definition and expansion of a function x - Drichlet's conditions - Assumptions for the validity of Fourier's series expansion and its theorems - Complex representation of Fourier series - problems related to periodic functions - graphical representation of FS - Fourier integrals - convergence of FS - some applications of Fourier transforms.

Text Books

Sl.No.	Author Name	Title of the Book	Publisher	Year and Edition
1	B.D.Gupta	Mathematical Physics	Vikas Publishing House Pvt ltd.	2006, 3rd Edition

2	Dass.H.K, Rama Verma	Mathematical Physics	S. Chand & Sons, New Delhi	2015, 7th Edition
3	G. Arfken	Mathematical methods for physics	Elsevier	2010, 6thEdition
4	Sathya Prakash	Mathematical Physics	S. Chand & Sons, New Delhi	2014, 6th Edition

Reference Books

Sl.No.	Author Name	Title of the Book	Publisher	Year and Edition
1	Rajput	Mathematical Physics	PragatiPrakasam, Meerut	2004, 17th Edition
2	Erwin Kreyszig	Advanced Engineering mathematics	Wiley Eastern Limited Publications	1993, 7th Edition
3	George.E Andrews Richard Askey Ranjan Ray	Special Function	Cambridge University	2010, 1st Edition

Web Resources

1. http://www.pbte.edu.pk/text%20books/dae/math_113/Chapter_09.pdf
2. http://home.iitk.ac.in/~sghorai/TEACHING/MTH203/ode14.pdf
3. http://www.egyankosh.ac.in/bitstream/123456789/12543/1/Unit-3.pdf
4. http://www.vyssotski.ch/BasicsOfInstrumentation/LaplaceTransform.pdf
5. http://olewitthansen.dk/Mathematics/Fourier_series.pdf

Pedagogy

- Lecture, PPT, Seminar, Quiz, and Assignment

SEMESTER – II

CODE	COURSE TITLE
18PHPC205	MATHEMATICAL PHYSICS – II

Category	CIA	ESE	L	T	P	Credit
Core	25	75	86	4	-	4

Preamble

The aim of this subject is to acquire basic knowledge of some advanced topics in Mathematical Physics, such as the group theory, tensor analysis and linear vector space and to provide a deeper understanding of the mathematics underpinning different fields of theoretical physics. It also provides the ability to formulate, interpret and draw inferences from mathematical solutions.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Analyze a formal treatment of probability theory and to equip with essential tools for statistical analysis	K4
CO2	Understand the basic concepts underlying complex analysis	K2
CO3	Apply group theory and integral transforms to solve mathematical problems of interest in physics	K3
CO4	Establish the relation for linearly dependent and independent vectors	K4
CO5	Build up a solid background of tensor analysis required to understand the properties of materials and their structures	K5

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	S
CO4	S	S	S	S	M
CO5	S	S	S	S	S

S- Strong; M-Medium; L-Low

Syllabus

Unit -I **(18 Hrs.)**

Probability :

Probability-Addition rule of Probability - Multiplication Law of Probability - Probability distribution - Binomial distribution - mean Binomial distribution - Standard deviation of binomial distribution - Poisson distribution - Normal distribution - characteristics of normal distribution - Applications of normal distribution.

Unit- II **(18 Hrs.)**

Complex variables :

Complex Algebra - Cauchy-Riemann Conditions - Cauchy's Integral Theorem - Cauchy's Integral

formula - Laurent expansion – singularities – Mapping - Conformal mapping - Calculus of residues.

Unit – III **(18 Hrs.)**

Group Theory :

Definition of Group - Subgroup, invariant group, abelian group, orthogonal and unitary groups - Homomorphism, isomorphism - Reducible and irreducible representations - Generators of Continuous groups.

Unit – IV **(18 Hrs.)**

Linear vector spaces :

Definition and Examples - Real Linear vector space - Uniqueness of Null and Reversed vectors - Scalar Products of Vectors : Definition of Scalar Product of two vectors, Scalar product for real linear vector spaces, Cauchy - Schwartz inequality - Metric Spaces - Linear Independence of vectors and basis for a vector space - Dimension of a vector space - Orthonormal basis - Vector Subspaces - Direct sum decomposition.

Unit – V **(18 Hrs.)**

Tensor Analysis :

Definition of Tensors - Contravariant, covariant and mixed tensors - addition and subtraction of Tensors - Summation convention - Symmetry and Anisymmmetry Tensor - Contraction and direct product - Quotient rule- Pseudotensors, Levi - Civita Symbol - Dual tensors, irreducible tensors - Metric Tensors - Christoffel symbols - Geodesics.

Text Books

Sl.No.	Author Name	Title of the Book	Publisher	Year and Edition
1	G. Arfken	Mathematical methods for physics	Elsevier	2010, 6th Edition
2	S.D. Joglekar	Mathematical Physics	Universities Press Pvt. Ltd.	2005, 1st Edition
3	H.K. Dass and R. Verma	Mathematical Physics	S. Chand & Company	2001, 2nd Edition
4	Sathya Prakash	Mathematical Physics	S. Chand & Sons, New Delhi	2014, 6th Edition

Reference Books

Sl.No.	Author Name	Title of the Book	Publisher	Year and Edition
1	Erwin Kreyszig	Advanced Engineering mathematics	Wiley Eastern	1993, 7th Edition
2	B.D. Gupta	Mathematical Physics	Vikas Publishing House Pvt.Ltd	2006, 3rd Edition

Web Resources

1. http://www.iiserpune.ac.in/~ayan/MTH201/Sahoo_textbook.pdf
2. http://www.math.s.chiba-u.ac.jp/~yasuda/ippansug/CV-bookfi.pdf
3. http://www.matfys.lth.se/education/FYS256/aryasetiawan.pdf
4. http://nptel.ac.in/courses/122106034/quantumphysics.pdf
5. http://nasc.ac.in/nasc/images/StudyMaterials/Physics/MScTensors.pdf

Pedagogy

- Lecture, PPT, Seminar, Quiz and Assignment

SEMESTER II

CODE	COURSE TITLE
18PHPCP02	CORE PRACTICAL-II ELECTRONICS

Category	CIA	ESE	L	T	P	Credit
Core	40	60	-	-	120	4

Preamble

The aim of this subject is to familiarize the basic concepts involved in the operation of solid state devices and to give an opportunity to do the experiments individually. It also helps to understand the basic concepts in ICs and digital devices and to acquire hands-on laboratory experience in utilizing modern test equipment.

Course Outcomes

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Acquire knowledge on the different experimental techniques involved in electronics.	K3
CO2	Explain the functions of various semiconductor devices and op amps characteristics.	K5
CO3	Develop the link connecting theory and designing workable circuits	K3
CO4	Analyze, design, build and troubleshoot the combinational circuits using digital ICs.	K4
CO5	Think innovatively and also improve the creative skills that are essential for present day requirements.	K4

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	S
CO4	S	S	S	S	M
CO5	S	S	S	S	S

S- Strong; M-Medium; L-Low

SEMESTER II

Syllabus

ELECTRONICS

(Examination at the end of Second Semester)

Any Twelve Experiments

1. Regulated and Dual power supply Construction.
2. Parameters of Op - amp.
3. Wave form generators - Op-amp.
4. Wein's bridge oscillator - Op-amp.
5. Phase Shift Oscillator - Op-amp
6. Active filters - Op-amp.
7. Frequency response of an Op - amp
8. Sign, scale changer, adder and Subtractor - Op-amp.
9. Op - Amp : Voltage to current and current to voltage converter
10. Analog computer setup for solving simultaneous equations.
11. UJT relaxation oscillator & Schmitt trigger using IC 555.
12. Construction of Half - Adder and Full - Adder circuits using NAND gates.
13. Construction of Half - Subtractor and full - Subtractor circuits using NAND gates.
14. A.C amplifier-inverting, non-inverting, voltage follower-op-amp.
15. Multiplexer and Demultiplexer.
16. Decode and Encoder
17. Construction of amplitude modulation circuit and to calculate the modulation index.
18. Two stage amplifier
19. SCR - Characteristics and its applications
20. Source Follower- FET.